(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 057 324**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 81306005.0

(22) Date of filing: 21.12.81

(51) Int. Cl.³: **B 01 F 3/08**, B 05 B 5/02, B 01 F 13/00

(30) Priority. 30.01.81 GB 8102823

(43) Date of publication of application: 11.08.82 Bulletin 82/32

(84) Designated Contracting States: AT BE CH DE FR GB IT LI LU NL SE

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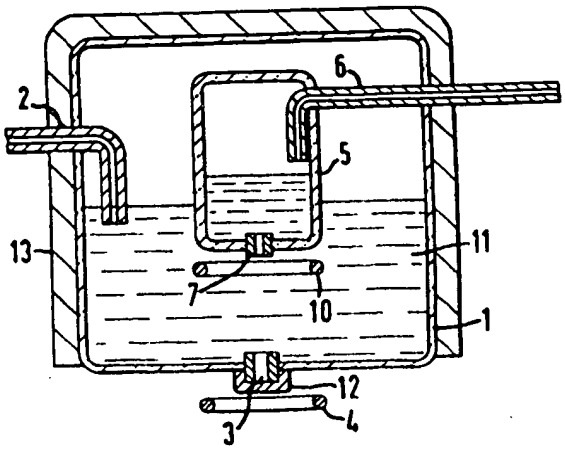
(54) Process of spraying emulsions and apparatus thereof.

(57) Method of forming and spraying emulsions of two immiscible liquids by introducing small amounts of highly charged disperse phase into a body of continuous phase followed by direct electrostatic spraying of the charged emulsions so formed. Also apparatus therefor.



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PROCESS OF SPRAYING EMULSIONS AND APPARATUS THEREOF

This invention relates to spraying emulsions. More particularly, it relates to new processes for forming emulsions and spraying the emulsions so formed, and to apparatus therefor.

An emulsion consists of small particles (generally of mean diameter in the range 0.1 to 10 microns) of a first liquid dispersed in a second liquid immiscible therewith. For example, an emulsion may be formed of finely divided particles of oil in water; or conversely, of finely divided particles of water in oil, the latter being commonly referred to as an invert emulsion. An emulsion is a two-phase system; the particles constitute the disperse phase, while the medium in which they are suspended is the continuous phase. The propertiies of emulsions naturally depend on the properties of the two phases, their relative proportions and the particle size of the disperse phase. Dilute emulsions, containing for example up to 10% or so of disperse phase, generally have, for example, a viscosity not dissimilar from that of the continuous phase; but increasing the proportion of the disperse phase leads to thickening, and the formation of immobile, scarcely pourable systems. The present invention is concerned with relatively dilute emulsions, not too thick to be able to flowlike liquids.

Emulsions have a variety of uses; for example in the food and pharmaceutical industries. Cosmetics may be formulated asemulsions, and so also may pesticides. The present invention relates to emulsions to be used as sprays.

Emulsions are generally formed by thoroughly agitating the two phases together, for example in a high shear mixer. This is a relatively inefficient process, consuming unnecessary energy.

Moreover, emulsions so formed are not necessarily stable, and may break down into separate bulk phases on storage. The present invention provides a more efficient method of forming emulsions, not dependent on mechanical mixing, and which prevents emulsion break-down by reducing or eliminating storage time.

According to the present invention we provide a process for forming and spraying a dilute emulsion of a first liquid in a second liquid immiscible therewith, which comprises passing small amounts of the first liquid into a body of the second liquid while electrically charging the first liquid relative to the second liquid to a potential sufficient to cause emulsification therein, and atomising the charged emulsion thereby formed. Such atomisation may be carried out wholly or partly by mechanical means, but conveniently it may be effected by passing the charged emulsion into a region of high electrical field strength thereby causing it to atomise.

The invention further comprises apparatus for forming and spraying an electrically charged emulsion of a first liquid in a second liquid immiscible therewith which comprises an orifice formed in an electrically conducting material communicating with a vessel for containing the second liquid, means for delivering the first liquid to and through the orifice, means for charging the orifice to a high potential, and a sprayhead for receiving the electrically charged emulsion formed at the orifice and for emitting the emulsion in the form of an electrically charged spray. Conveniently the sprayhead comprises an electrically conducting surface for receiving the electrically charged emulsion, and means for creating a field strength at the surface sufficient to atomise the emulsion therefrom in the form of a fine spray.

The emulsions, being electrostatically charged, are attracted to spray targets and coat them more evenly than

uncharged sprays would do. Electrostatic force fields carry the charged particles behind the target, so as to coat all sides of it. The method and apparatus of the invention may be used for spraying paints and like coatings on to structures or articles of manufacture, and (with particular advantage) for spraying pesticides (eg, insecticides, herbicides, fungicides and the like) on to crops or weeds. Conveniently emulsions according to the invention comprise from about 1 to about 10% by weight disperse phase, though higher and lower amounts may be used where appropriate.

A specific embodiment of the invention will now be described with reference to the drawings, in which:

Figure 1 is a vertical cross-section through a spraying device according to the invention adapted to spray an invert emulsion of aqueous herbicide in oil;

Figure 2 is a circuit diagram for the device;

Figure 3 is an alternative circuit diagram for the device.

In figure 1, a container 1 of insulating material (glass) is provided with an earthed jacket 13 of conductive material, and with a conduit 2 for delivering liquid. In the base of the container 1 is a metallic exit nozzle 3, with a bore of capillary size. Below the container 1, and disposed symmetrically around the outlet of nozzle 3, is a metal ring 4 connected (as shown in Figure 2) to earth 19. Centrally within the upper part of the container 1 is a second container 5 of insulating material (glass) fed by a liquid delivering conduit 6. In the base of container 5 is a second metallic exit nozzle 7, of capillary dimensions. Both nozzles 3 and 7 are connected (as shown in Figure 2) to a source of high potential 8 (0-20 kilovolts, 200 microamp module) via a switch 9. Below the container 5, within the container 1, and symmetrically disposed around the outlet of the nozzle 7, is a second earthed metal ring 10. The nozzle 3 may be closed by an exterior cap or bung 12.

In operation, a hydrocarbon oil 11 is passed into the container 1 from the conduit 2 until the level of oil 11 is above the base of container 5. An aqueous solution containing 7% by weight of paraquat dichloride is passed through conduit 6 into container 5. Capillary-sized droplets of the aqueous solution pass out through nozzle 7 and sink through the oil 11. The switch 9 is then closed, applying a voltage of the order of 15 kilovolts to the nozzles 7 and 3. At once the passage of capillary-sized droplets into the oil 11 ceases, and the oil becomes cloudy, indicating the formation of an emulsion. The liquid in the container 1 becomes turbulent, exhibiting negative surface tension due to the electrical charge it carries. The cap 12 is then removed, and the emulsion (containing about 4% weight disperse phase) issues from the nozzle 3. The electric field between the nozzle 3 and the earthed ring 4 causes the emulsion to atomise as fine particles, which pass outwards and are attracted to suitable targets, eg, weeds. Meanwhile the flows of oil 11 through conduit 2 and of aqueous solution through conduit 6 are adjusted to maintain the levels of liquid in containers 1 and 5 constant.

The particle size of the disperse phase in the emulsion may be controlled by control of the field strength at the nozzle 7; eg, by varying the distance between the nozzle 7 and the ring 10, or, more conveniently, by varying the applied voltage. The stronger the field the smaller are the droplets. Similarly, the particle size of droplets in the atomised emulsion may be controlled by control of the field strength at the nozzle 3. This may be done by varying the voltage on the nozzle 3, the position of the ring 4, or by applying a variable voltage (positive or negative with respect to the potential of the nozzle 3) to the ring 4 instead of earthing it.

The same apparatus may be used, if desired, to form an emulsion in which water or an aqueous solution is the continuous phase and oil is the disperse phase, by feeding

water to container 1 and oil to container 2.

If desired, the nozzle 7 may be charged by induction, as shown in Figure 3. If the nozzle 7 is connected to the earth 19, and the source of potential 8 to ring 10, a strong charge of opposite sign will be induced on nozzle 7 and liquid passing through will be charged by contact in the same way as if the nozzle 7 were connected to source of potential 8, except that the charge will be of opposite sign. An emulsion will be formed in just the same way, with the charging current being taken from earth. This saves current at nozzle 7, but slightly more is used at nozzle3, because the emulsion has to be discharged and recharged in the opposite sense before atomisation. In any case the power consumption of the device is not high, and is readily adapted to use in portable devices powered by dry cells, or even solar cells. For agricultural spraying, however, it will often be convenient to mount the device on a vehicle (eg a tractor or aircraft) and power it from a power source carried on the vehicle (eg the tractor battery).

If desired, (eg to obtain a greater throughput rate than is normally conveniently available through electrostatic atomisation) the emulsion may be atomised wholly or partly mechanically, eg from a pressure nozzle or spinning cup or disc. Generally, however, electrostatic atomisation is preferred, with advantages which may include lower energy usage, apparatus with fewer or no moving parts, and spray droplets of very regular and controllable size.

1. A process for forming and spraying a dilute emulsion of a first liquid in a second liquid immiscible therewith which comprises passing small amounts of the first liquid into a body of the second liquid while electrically charging the first liquid relative to the second liquid to a potential sufficient to cause emulsification therein, and atomising the charged emulsion thereby formed.

2. A process as claimed in claim 1 wherein atomisation is effected by passing the charged emulsion into a region of high electrical field strength.

3. A process as claimed in either of claims 1 or 2 wherein the first liquid comprises a pesticide.

4. Apparatus for carrying out the process of claim 1 which comprises an orifice formed in an electrically conducting material communicating with a vessel for containing the second liquid, means for delivering the first liquid to and through the orifice means for charging the orifice to a high potential and a sprayhead for receiving the electrically charged emulsion formed at the orifice and for emitting the emulsion in the form of an electrically charged spray.

5. Apparatus as claimed in claim 4 in which the sprayhead comprises an electrically conducting surface with means for creating a field strength at the surface sufficient to atomise the emulsion therefrom in the form of a fine spray.

6. Apparatus as claimed in claim 5 wherein the means for creating field strength at the surface comprises an electrode at a potential different from that of the surface.

7. Apparatus as claimed in claim 6 in which the electrode is earthed.

8. Apparatus as claimed in any of claims 4 to 6 which is provided with an electrode adjacent the orifice, and at a different potential therefrom, to intensify the electric field thereat.

9. Apparatus as claimed in claim 8 wherein the electrode adjacent the orifice is earthed.

10. Apparatus as claimed in any of claims 4 to 9 mounted on a vehicle and adapted for agricultural spraying.

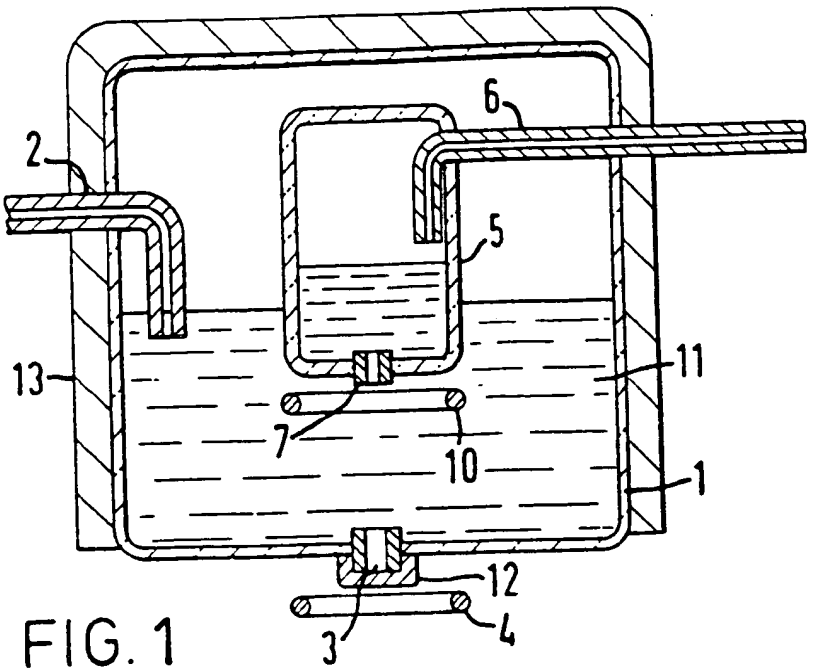

FIG. 1

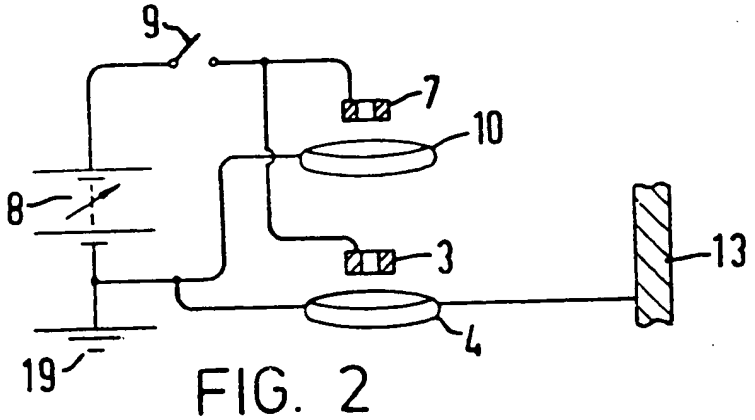

FIG. 2

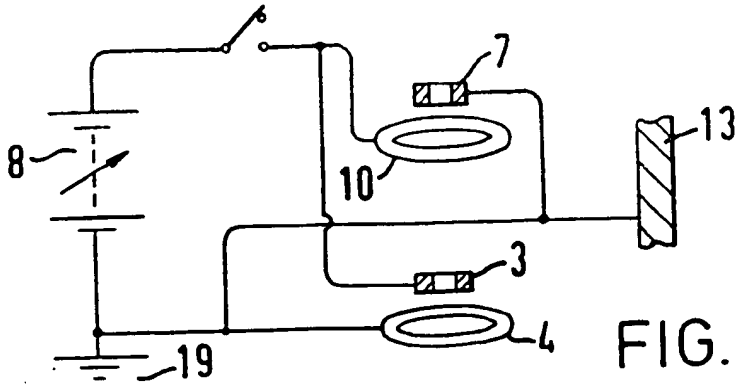

FIG. 3

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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
Y	FR - A - 639 245 (AUERBACH) * Whole document, especially page 1, lines 7-21; page 2, lines 3-23, 34-43, 47-50; figures 1-3 *	1,2,4, 8,9	B 01 F 3/08 B 05 B 5/02 B 01 F 13/00
Y	GB - A - 1 569 707 (COFFEE) * Whole document, especially claims 1-6; figures 1,7,9,13 *	1,3-7, 10	
Y	FR - A - 1 017 481 (O.N.E.R.A.) * Page 4, left-hand column, lines 32-37; figure 1 *	1,3-6	TECHNICAL FIELDS SEARCHED (Int.Cl. ³) B 01 F B 05 B
Y	GB - A - 1 564 973 (LAW) * Page 1, lines 59-63; page 2, lines 33-71; claim 1; figure 1 *	3-6,10	
Y	US - A - 3 873 023 (MOSS) * Column 4, lines 42-47; column 8, lines 65-68; column 9, lines 1-8, 43-48; figure 2 *	1,4	CATEGORY OF CITED DOCUMENTS
Y	GB - A - 320 919 (PROVIA) * Page 1, lines 46-53; figures 1-4 *	1	X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons
	./.		&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29-04-1982	AST

EPO Form 1503.1 06.78

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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
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A	FR - A - 1 122 243 (BONNET) * Page 1, left-hand column, lines 15-19; figures 1,2 *	1,4	
A	FR - A - 1 182 266 (JAPELLA) * Figure 1 *		TECHNICAL FIELDS SEARCHED (Int. Cl.³)
A	US - A - 3 131 131 (WEHNER)		